REMARKS/ARGUMENTS

Favorable reconsideration of this application as presently amended and in light of the following discussion is respectfully requested.

Claims 26-37, 39 and 40 are presently active in this case, Claims 1-8, 11-16, 18-19 and 22-25 canceled, Claims 39 and 40 added and Claim 26 amended by way of the present amendment.

In the outstanding Office Action, Claims 1-8, 11-19 and 22-37 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Publication 2003/0143328 to Chen et al. in view of WO 03/021002 to Strang.

Turning now to the merits, in order to expedite issuance of a patent in this case, Applicant has cancelled apparatus claims 1-25 and amended independent method Claim 26 to clarify the patentable features of the present invention over the cited references. Specifically, Applicant's Claim 26, as amended, recites a method of operating a plasma processing system in order to deposit a film containing a metal or a semiconductor on a substrate using atomic layer deposition (ALD). The method includes the steps of adjusting a background pressure in a process chamber, wherein the background pressure is established by continuously flowing a first gas flow of a first precursor into the process chamber, the first precursor including a metal or semiconductor element which is a main component of the film to be deposited on the substrate. The first precursor is selected from the group consisting of WF_6, $W(CO)_6$, $TaCl_5$, PDEAT (pentakis(diethylamido) tantalum), PEMAT (pentakis(ethylmethylamido) tantaluum), $TaBr_5$, TBTDET (t-butylimino tris(diethylamino) tantalum), molybdenum hexafluoride, Cu(TMVS)(hfac), (Trimethylvinylsilyl) hexafluoroacetylacetonato Copper I, CuCl, $Zr(NO_3)_4$, $ZrCl_4$, $Hf(NO_3)_4$, $HfCl_4$, niobium pentachloride, zinc dichloride, $Si(NO_3)_4$, $SiCl_4$, dichlorosilane, $Ti(NO_3)$, $TiCl_4$, TiI_4, tetrakis(diethylamino)titanium, tetrakis(dimethylamino)titanium, aluminum trichloride, trimethylaluminum, gallium nitrate,

trimethylgallium, and Cr oxo-nitrate. Also recited is igniting a processing plasma in the process chamber by providing an RF signal at a first power level, and pulsing a second gas flow of a second precursor through a pulsed injection manifold to the process chamber at a first time, the second gas comprising a second precursor including at least one of H_2, N_2, O_2, H_2O, NH_3, or H_2O_2, which provides a reduction reaction with the first precursor to deposit the metal or semiconductor main component of the film on the substrate. Also recited is pulsing a RF power to a substrate holder by amplifying the first power level at a second time, to a second power level in order to improve conformal coating of high aspect ratio features of the substrate, and sequentially depositing at least one monolayer of the film containing a metal or a semiconductor using the first gas and the second gas, while periodically amplifying to the second power level in order to improve conformal coating of the monolayer on high aspect ratio features in the substrate.

Thus, Applicant's method Claim 26, as amended, positively recites the detailed method steps of an atomic layer disposition (ALD) process for depositing a film containing a metal or semiconductor. In particular, Claim 26 recites ***continuously flowing*** … the ***first precursor including a metal or semiconductor element which is a main component of the film to be deposited on the substrate,*** and lists specific gases including the metal or semiconductor element. Claim 26 further recites ***pulsing*** a second gas flow of ***a second precursor…, which provides a reduction reaction with the first precursor to deposit the metal or semiconductor main component of the film on the substrate.*** Also recited is ***pulsing a RF power to a substrate holder by amplifying said first power level at a second time, to a second power level in order to improve conformal coating of high aspect ratio features*** of the substrate. As discussed in Applicant's specification, this combination of features provides improved conformal coating in an ALD process.[1]

[1] See Applicants' specification at paragraph [0018] and Figure 2.

In contrast, the cited reference to Chen et al. discloses a plasma enhanced deposition system wherein the plasma is created adjacent to a processing region where a substrate is processed. Figures 6, 7 and 10 of Chen et al. show that a first gas may be continuously provided to the process chamber while a second gas is pulsed to the process chamber. In particular, each of these figures shows continuous flow of reduction gas H_2 or H_2/NH_3, and pulsing of the metal containing gas $TiCl_4$. Thus, each of these figures (and their corresponding text) demonstrate that it is the reduction gas, and not the main component gas (i.e. the metal or semiconductor containing gas) that is continuously flowed.

Therefore, Chen et al. does not disclose "continuously flowing a first gas flow of a first precursor into the process chamber, the first precursor including a metal or semiconductor element which is a main component of the film to be deposited on the substrate," as now recited in Claim 26. While Chen et al. discloses at least some of the specific main component precursors listed in Claim 26, as noted above Chen et al. makes clear that these materials are pulsed, and does not show these gases as being continuously flowed in the process chamber as required by Claim 26.

Similarly, Chen et al. does not disclose "pulsing a second gas flow of a second precursor … including at least one of H_2, N_2, O_2, H_2O, NH_3, or H_2O_2, which is used to provide a reduction reaction with the first precursor to deposit the metal or semiconductor main component of the film on the substrate," as now recited in Claim 26. As noted above, Figures 6, 7 and 10 of Chen et al. specifically, show H_2 and N_2 gas being continuously flowed rather than pulsed into the process chamber.

Further, as discussed in the previous response in this case, there is no teaching in Chen et al. of providing a first power level on a substrate holder to ignite a plasma, and periodically pulsing by increasing the first power level to a second power level that enlarges a

sheath thickness of the plasma in order to improve conformality of the ALD process. This provides another distinction of the claimed invention over Chen et al.

The secondary reference to Strang does not correct the deficiencies of Chen et al. Strang is directed to an etching process whereby a CF_x reactants chemically etch the surface of the substrate while positively charged ions such as Ar^+ provide energy to catalyze the surface reactions.[2] Therefore, Strang does not disclose the first or second precursors listed in Claim 26. Indeed, Strang does not disclose an ALD process process at all, and thus does not disclose any "a first precursor having a main component of a film to be deposited" or any "second precursor to provide a reduction reaction."

Thus, as discussed above, the combination of Chen et al. and Strang does not disclose "continuously flowing a ... first precursor including a metal or semiconductor element which is a main component of the film to be deposited on the substrate," or "pulsing a second gas flow of a second precursor ... which is used to provide a reduction reaction with the first precursor to deposit the metal or semiconductor main component of the film on the substrate," as now recited in Claim 26.

Applicant further submits that it would not be obvious to combine the features of Chen et al. and Strang in an effort to arrive at the claimed invention. As discussed above, continuous flow of the main component gas and pulsing of the reduction gas in an ALD process, along with increasing the RF power and the substrate holder from a first level to a second level in conjunction with pulsing of the reduction gas provides an advantage of improving conformality of deposition within high aspect ratio features using the ALD process.[3] It is Applicant who discovered this advantage. One of ordinary skill in the art would not predict that the detailed combination of process steps in method Claim 26 would result in some advantage for the ALD process.

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[2] See Strang at paragraphs [0003] and [0034].
[3] See Applicants' specification at paragraphs [0017] and [0018].

Therefore, Applicant's Claim 26 patentably define over the cited references. Moreover, as Claims 27-37 and 38-39 depend from Claim 26, these claims also patentably define over the cited references. Nevertheless, Applicant has added new Claims 39 and 40 to further emphasize distinctions over the cited references. Claim 39 recites that "said pulsing a second gas flow comprises pulsing a gas flow of a second precursor that does not include a metal or semiconductor element therein." Claim 40 recites "wherein said pulsing a second gas flow of a second precursor occurs after a monolayer of the first precursor is adsorbed on a surface of the substrate." Applicants specification provides numerous examples of first precursors including a metal or semiconductor, and which is adsorbed (as a monolayer) to the substrate during a first step of the ALD process. The specification also provides numerous examples of a second pulsed precursor excluding a metal and semiconductor, and which provide a reduction reaction of the first precursor during the second step of the ALD process. At least these examples provide support for Claims 39 and 40. Neither Chen et al. nor Strang disclose these further details of the inventive ALD method.

Consequently, in view of the present amendment, no further issues are believed to be outstanding in the present application and the present application is believed to be in condition for formal allowance. An early and favorable action is therefore respectfully requested.

Respectfully submitted,

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